Particle Ratios at High p_T at LHC Energies

G G Barnaföldi, P Lévai

E-mail: bgergely@rmki.kfki.hu
MTA KFKI RMKI P.O. Box 49, Budapest 1525, Hungary

B A Cole
Nevis Laboratory, Columbia University, New York, NY, USA

G Fai
Department of Physics, Kent State University, Kent, OH, USA

G Papp
Department of Theoretical Physics, ELTE Pázmány P. 1/A, Budapest 1117, Hungary

Abstract. Hadron production has been calculated in a pQCD improved parton model for *pp*, *dA* and heavy ion collisions. We applied KKP and AKK fragmentation functions. Our jet fragmentation study shows, that hadron ratios at high p_T depend on quark contribution mostly and less on the gluonic one. This finding can be seen in jet-energy loss calculations, also. We display the suppression pattern on different hadron ratios in *PbPb* collisions at LHC energies.

The precision of pQCD based parton model calculations was enhanced during the last decade. The calculated spectra allow to make predictions not only for the hadron yields, but for sensitive particle ratios and nuclear modifications. For the calculation of particle ratios new fragmentation functions are needed not only for the most produced light mesons, but for protons also. From the experimental point of view one requires identified particle spectra by RHIC and LHC. Especially the ALICE detector has a unique capability to measure identified particles at highest transverse momenta via Čherenkov detectors. The $\pi^{\pm}/K^{\pm}$ and $K^{\pm}/p(\bar{p})$ ratios can be measured up to 3 GeV/c and 5 GeV/c respectively.

Here we calculate hadron ratios in our next-to-leading order pQCD improved parton model based on Ref.[1] with intrinsic transverse momenta, determined by the expected c.m. energy evolution along the lines of Ref.[1]. The presented ratios are based on π, K and p spectra which were calculated by AKK fragmentation functions [2]. First we compare calculated particle ratios to the data of the STAR collaboration measured in $AuAu$ collisions at $\sqrt{s} = 200$ AGeV RHIC energy [3, 4]. Predictions for high-p_T hadron ratios at RHIC and at LHC energies in most central $(0-10\%)$ $PbPb$ collisions are also shown in Fig. 1.

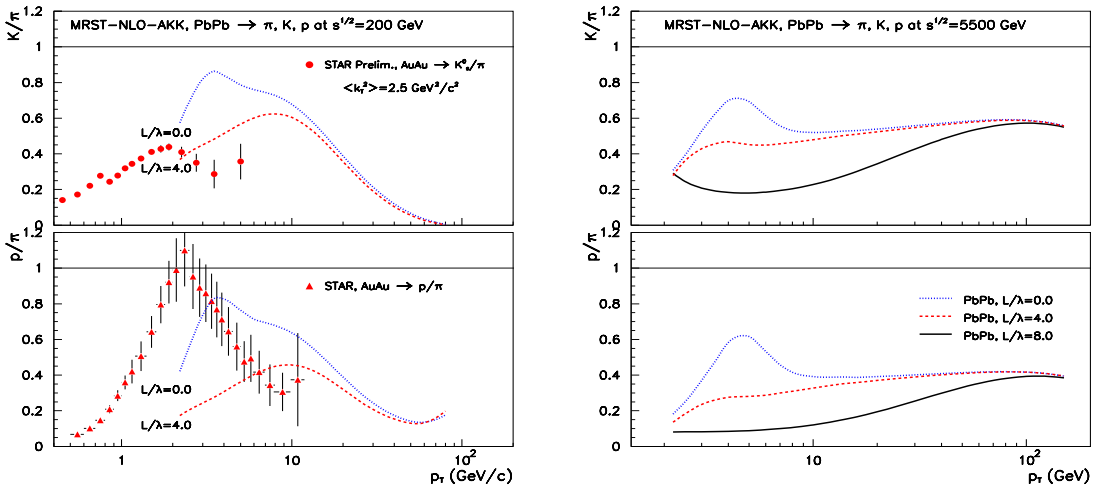

Figure 1. Calculated charge-averaged K/π and p/π ratios in AA collisions at RHIC and LHC energies. RHIC curves are compared to STAR[3, 4] data at $\sqrt{s} = 200$ AGeV.

On the *left panel* of Fig. 1, particle ratios are compared to $AuAu$ collisions at $\sqrt{s} = 200$ AGeV STAR K/π (*dots*) and p/π (*triangles*) data. The agreement between the RHIC data and the calculations at RHIC energy can be considered acceptable at $p_T \gtrsim 5$ GeV/c, with an opacity of $L/\lambda = 4$. However, at lower momenta, where pQCD is no longer reliable, the ratios differ from the calculated curves.

The *right panel* shows calculations for $PbPb$ collisions for $\sqrt{s} = 5.5$ ATeV energy. Using a simple $\mathrm{d}N/\mathrm{d}y \sim 1500 - 3000$ estimation, we expect a $L/\lambda \approx 8$ opacity in most central $PbPb$ collisions. For comparison, we plotted the $L/\lambda = 0$ and 4 values also. The lower- and intermediate-p_T variation of the hadron ratios arise from the different strengths of the jet quenching for quark and gluon contributions[5]. Due to the quark dominated fragmentation, the difference disappears at high-p_T in the ratios.

Acknowledgments: Special thanks to Prof. John J. Portman for computer time at Kent State University. Our work was supported in part by Hungarian OTKA T047050 and NK62044, by the U.S. Department of Energy under grant U.S. DE-FG02-86ER40251, and jointly by the U.S. and Hungary under MTA-NSF-OTKA OISE-0435701.

References

[1] G.G. Barnaföldi, P. Lévai, G. Papp, G. Fai and B.A. Cole, arXiv:hep-ph/0703059 (2007).
[2] S. Albino, B.A. Kniehl and G. Kramer, *Nucl. Phys.* **B725** 181 (2005); *ibid.* **B734** 50 (2006).
[3] STAR preliminary data, presented by Ming Yao on SQM'07 conference
[4] B.I. Adelev *et al.* [STAR], *Phys. Rev. Lett.* **97** 152301 (2006)
[5] P. Lévai, G. Papp, G. Fai and M. Gyulassy, *Acta. Phys. Hung.* **A27** 459 (2006).